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GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF TEXTILE & FIBER ENGINEERING

FINAL REPORT

ON THE

NASA/USRA ADVANCED DESIGN PROGRAM ACTIVITY 1991/92

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The NASA/USRA support of our design effort has been most helpful in enhancing the teaching of our design courses. The monetary award has the obvious advantage of providing needed Graduate Teaching Assistance support and also other funds for supplies, travel, etc. Our TA has also gained valuable experience by participating in the summer internship program. The interest shown by our Langley mentor, Dr. John Buckley, has been most helpful. One of the most important benefits has been that the students have been exposed to interesting and challenging problems which cause them to ponder constraints which they have not previously considered. I believe that working on these space-related problems has been a valuable experience which has greatly broadened their education.

Interdisciplinary Activity:

The School of Textile & Fiber Engineering continued to pursue design projects with the Mechanical Engineering School giving the students an outstanding opportunity to interact with students from another discipline. Four problems were defined which had aspects which would be reasonably assigned to an interdisciplinary design team. The design problems addressed are attached and formatted as separate papers. The titles and abstracts are as follows:

I. LUNAR PREFORM MANUFACTURING

Gregory N. Leong, Sandra Nease, Vicky Lager, Raffy Yaghjian, Chris Waller

ABSTRACT

A design for a machine to produce hollow, continuous fiber reinforced composite rods of lunar glass and a liquid crystalline matrix using the pultrusion process will be presented. The glass fiber will be produced from the lunar surface, with the machine and matrix being transported to the moon. The process is adaptable to the low gravity and near-vacuum environment of the moon through the use of a thermoplastic matrix in fiber form as it enters the pultrusion process.

With a power consumption of 5 kW, the proposed machine will run continuously, unmanned in fourteen day cycles, matching the length of moon days. A number of dies could be included that would allow the

machine to produce rods of varying diameter, I-beams, angles, and other structural members. These members could then be used for construction on the lunar surface or transported for use in orbit.

The benefits of this proposal are in the savings in weight of the cargo each lunar mission would carry. The supply of glass on the moon is effectively endless, so enough rods would have to be produced to justify its transportation, operation, and capital cost. This should not be difficult as weight on lunar mission is at a premium.

II. DUST CONTROL FOR ENABLER

Kevin Hilton, Chad Karl, Mark Litherland, David Ritchie, and Nancy Sun

ABSTRACT

The dust control group designed a system to restrict dust that is disturbed by the ENABLER during its operation from interfering with astronaut or camera visibility. This design also considers the many different wheel positions made possible through the use of articulation joints that provide the steering and wheel pitching for the ENABLER. The system uses a combination of brushes and fenders to restrict the dust when the vehicle is moving in either direction and in a turn. This design also allows for ease of maintenance as well as accessibility of the remainder of the vehicle.

III. AN INDUSTRIAL SEWING MACHINE VARIABLE SPEED CONTROLLER

Christa Estes, Charles Spiggle, Shannon Swift, Stephen Van Geffen, and Frank Youngner

ABSTRACT

The apparel industry is attempting to move in a new direction in the coming decade. Since the invention of a electrically powered sewing machine, the operator has been seated. Today, companies are switching from a sit down operation to a stand up operation involving modular stations. The old treadle worked well with the sitting operator, but problems have been found when trying to use the same treadle with a standing operator. This report details a new design for a treadle to operate an industrial sewing machine that has a standing operator.

Emphasis is placed on the ease of use by the operator , as well as, the ergonomics involved. Procedures for testing the design are included in the Report along with possible uses for the treadle in other applications besides an industrial sewing machine.

IV. ENABLER OPERATOR STATION

Andrea Bailey, John Keitzman, Shirlyn King, Rae Stover, and Torsten Wegner

ABSTRACT

The objective of this project was to design an on board operator station for the conceptual Lunar Work Vehicle (LWV). This LWV would be used in the colonization of a lunar outpost. The details that follow, however, are for an earth-bound model. Several recommendations are made in the appendix as to the changes needed in material selection for the lunar environment. The operator station is designed dimensionally correct for an astronaut wearing the current space shuttle EVA suit (which includes life support).

The proposed operator station will support and restrain an astronaut as well as provide protection from the hazards of vehicle rollover. The threat of suit puncture is eliminated by rounding all corners and edges. A step-plate, located at the front of the vehicle, provides excellent ease of entry and exit. The operator station weight requirements are met by making efficient use of rigid members, semi-rigid members and woven fabrics.

IV. DESIGN FOR PRODUCING FIBERGLASS FABRIC IN A LUNAR ENVIRONMENT

Rafer M. Benson, Dana R. Causby, Michael C. Johnson, Mark A. Storey, Dai T. Tran, Thomas A. Zahr

ABSTRACT

The purpose of this project was to design a method of producing a fabric material on the lunar surface from readily available glass fibers. Various methods for forming fabrics were analyzed to determine which methods were appropriate for the lunar conditions. A non woven process was determined to be the most suitable process for making a fabric material out of fiberglass under these conditions. Various resins were

considered for adhering the fibers. A single thermoplastic resin (AURUM) was found to be the only applicable resin. The end product of the process was determined to be suitable for use as a roadway surfacing material, canopy material, reflective material, or packaging material. A cost analysis of the lunar process versus shipping the end-product from the earth suggests that the lunar formation is highly feasible. A design for a lunar, non woven process was determined and included in the following document.

Challenges to Textile Engineering Students

The design projects briefly described above provided a unique challenge because of the harsh lunar environment which is hostile to most textile fibers. The extremely important requirement to minimize weight for space flight gave the students a new perspective on design constraints.

Challenges to our Curriculum:

Our present curriculum requires our seniors to take two quarters of engineering design in order to fulfill the ABET requirement for a capstone design course. The School has chosen to divide the courses into "wet-processing" and "dry-processing". This does constrain us to keeping the projects to a 10-week time period. If we were to carryover projects from one quarter to another, the students would not see the complete design cycle and the educational value would be diminished. We must ask ourselves how we may provide the best design experience and still provide NASA with a reasonable return on their investment.

Appreciation:

The School of Textile & Fiber Engineering is most appreciative of the support and assistance of both the staff of USRA and Dr. John Buckley at NASA Langley. They have certainly been of great assistance in making our participation meaningful for the students in our design courses for the past three years. Thanks go to all.